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THE FLOWER OF CHIMAPHILA.

THEO. HOLM.

(Plate 156.)

THE *Pyrolaceae*, *Pyrola* as well as *Moneses* and *Chimaphila*, were well known to the older botanists, and described under the name *Pyrola*. Brunfels (1532) knew *Pyrola rotundifolia;* Clusius (1576), *P. secunda*, *Moneses* and *Chimaphila umbellata;* Plukenet (1696), *Chimaphila maculata;* Haller (1740), *P. minor, etc.* Fuchs (1549), however, used the name *Limonium*, but his figure leaves no doubt of being intended for some species of *Pyrola*. Some few other genera were also called *Pyrola*, among them *Trientalis* and *Cornus canadensis* (Bauhin), *Parnassia* (Morrison), *Epigaea* (Plukenet), and *Goodyera* (Loeselius).

Since then the genus has been divided by Pursh, who segregated *Chimaphila*, and by Salisbury, the author of *Moneses*. On the other hand, *Amelia* and *Thelaia* Alefeld,[1] and *Actinocyclus* Klotzsch are considered only as subgenera of *Pyrola* in the works of Bentham, Hooker, Gray, Engler and Prantl and several others. Though Pursh established *Chimaphila*, Michaux had already called attention to the pronounced difference in habit and floral structure, when comparing *Pyrola umbellata* and *P. maculata* with the other species.[2]

A few years after Pursh, Nuttall redescribed *Chimaphila*, mentioning the actual presence of a style "very short, immersed in the germ," besides "germ surrounded at the base by a glandular ring." This is

[1] For references consult the bibliography appended.

[2] The classification, proposed by Elias Fries (1840), according to which *Moneses* should represent a species of *Chimaphila*, namely *Ch. uniflora* Fr., has not been adopted except by Lange (l. c., p. 427).

the earliest record of a nectary in the *Pyrolaceae*, and with regard to *Hypopithys* and *Monotropa*, Nuttall described also the segments of the corolla as having "a cucullate nectariferous base," and the development of "ten very short recurved filiform appendices alternating with the stamens."

In Europe the *Pyrolaceae* were described and several figured by Radius (1821), who was familiar with the works of Pursh and Nuttall, but without making any mention of the nectary in *Chimaphila*. On the other hand, Alefeld (1856), in his comprehensive treatment of the *Pyrolaceae*, called attention to *Pyrola secunda*, in which he observed: "ovarium basi nectariis 10, compressis, acutis, triangularibus, copiose mel secernentibus, filamentis alternantibus, valliculis fundo petalorum oppositis." This author described *Moneses* as having "ovarium nectariis destitutum," but said nothing about *Chimaphila*, evidently not knowing the work of Nuttall. Meanwhile Irmisch, who studied the *Pyrolaceae* so very carefully from a morphological and biological viewpoint, succeeded in finding a discus or nectarium in *Chimaphila umbellata*, independently of Nuttall, whose work he would have cited, if he had read it.

Finally, according to Drude, a 10-dentate nectar-secreting discus occurs in *Moneses*. But no further discoveries have been recorded of nectaries in the other species. Bentham and Hooker mention the nectaries very briefly "10-crenatus" in *Pyrola secunda*, "obscurus" in *Moneses*, and "inconspicuus" in *Chimaphila*, and Gray (Synopt. Flora) mentions the disk as "obsolete or obscure" in *Pyrolineae*, except in *Pyrola secunda*, where the "hypogynous disk" is described as "10-lobed."

Very few authors have given much attention to this structure. Torrey, however, observed the disk in *Chimaphila* to be glandular, and Blytt, in his Flora of Norway, recorded the facts brought out by Alefeld and Irmisch. In describing the floral diagram of the *Pyrolaceae*, Eichler cites the observations of Irmisch and Alefeld, while Sachs gives a figure of the nectar-glands in *Chimaphila*. Conversely, in the more recently published work by Warming, "Spermatofyter" (1912), the *Pyrolaceae* (*Pyrola*, *Moneses*, and *Chimaphila*) are said to be destitute of honey, while nectariferous glands are attributed to *Monotropa*. Finally, in the North American Flora, Rydberg mentions only the nectaries in *Pyrola secunda*. Thus, considered altogether, the accounts of these structures are anything but complete,

and it seems strange that the observations made by Nuttall, Alefeld, Irmisch, and Drude have been so frequently overlooked.

With regard to the pollination of the flower in *Chimaphila*, we have not been able to find any reference to the matter in literature. Hermann Mueller has described the process in *Moneses* and some few species of *Pyrola*, and Warming in *P. grandiflora*. Sprengel described it in *Monotropa*, but neither in *Pyrola* nor *Chimaphila*. We might state at once that Mueller considered self-pollination to be excluded from *Moneses* on account of the mutual position of the stamens and stigma, but with the admission that he failed to observe any insects in the flowers. In *Pyrola minor*, on the other hand, this author did finally succeed in observing visitors, some beetles and flies. According to Warming, spontaneous self-pollination seems possible in *Pyrola rotundifolia*, and especially so in *P. grandiflora*. By these authors the pollen-tetrads are described as glabrous and readily falling out of the anthers.

In *Chimaphila umbellata* and *Ch. maculata* the flowers are fragrant, notably in the latter, and we observed a secretion of nectar in the form of minute drops (mostly ten at the same time) from the discus, thus corroborating the statements of Irmisch. The flowers are very conspicuous by their color, pink in *Chimaphila umbellata*, creamy white in the other species, with the anthers deep rose to purplish in the former, yellowish brown in the latter. These facts, in connection with the fragrance, induced us to believe that pollination by insects would be most natural. Nevertheless, we failed to observe a single case out of several hundreds where insects were actually present. Probably the pollinators are nocturnal insects.

The flowers, even as buds, are pendulous in both species and perfectly polypetalous. They remain pendulous in *Chimaphila umbellata* for some time after pollination, while in the other species the peduncle often becomes erect, holding the flowers in a position fully exposed to lateral light. The ten stamens have their filaments widened considerably and thickened, ciliate in *Chimaphila umbellata* (figs. 4–6), densely hairy along the margins and all over the lower face in *Ch. maculata* (figs. 9–11). In both species the anthers are extrorse in the bud, with the pores in the lower portion, but become inverted at a later period, thus placing the pores at the top. Besides that, the two halves of the anther are widely separated from each other and conspicuously 2-horned, with each pore placed at the end of its own

tube (figs. 4, 9, and 14). The pollen-grains are united into tetrads, which are viscid and fall out in small clumps, while in the other *Pyrolaceae* the pollen is dry and very light. Viscid pollen is known from some of the *Rhodoraceae*. The style is partly immersed in the depressed summit of the globular ovary (fig. 13); the stigma is broad, orbicular, and disc-shaped, with the margin 5-crenate. The ovary (fig. 12) is not smooth, but shows five linear ridges alternating with five bifurcate, and is surrounded at the base by a cup-shaped disc, pale green, with the margin entire, and secreting nectar (figs. 7, 12 and 13).

The flowers are protogynous. Before they open, the stigma is free and very viscid (fig. 1), while the anthers are not yet ready to shed the pollen (fig. 12). For even if the pores are open at a very young stage of the flower, some time is required before the anthers turn over and shed the pollen. When the flower opens, the anthers are held in a horizontal position with the pores in the periphery (fig. 2). In *Chimaphila umbellata* they become vertical after pollination (fig. 3); in *Ch. maculata*, they are almost vertical in the flower just opened, becoming more spreading, almost horizontally, after pollination (fig. 8). At the time of pollination the anthers have thus turned over with the pores pointing more or less towards the stigma, but owing to the position of the stigma, the pollen can hardly reach its viscid surface, unless by means of visiting insects. Moreover, the pollen is not shed so very readily; some movement is necessary before the sticky pollen-masses can come out. It would thus appear as if the pollination must be effected by means of insects which, attracted by the odor, visit the flowers and, in sucking the honey, necessarily touch the anthers. The movement of the anthers will cause the heavy, viscid pollen to fall out, and, covered with pollen, the insects may transfer it to another flower; thus cross-pollination becomes established. Fruiting specimens of both species of *Chimaphila* are abundant every year, and the number of seeds is immense. Nevertheless, seedlings of these species, or plants developed from seeds, are extremely seldom found. This may be on account of the great difficulty in striking the proper conditions, soil especially, for the germination of the seeds. The generally social occurrence and the very wide geographic distribution of the *Pyrolaceae* depends upon their power to spread by means of stolons, as well as by root-shoots.

Nuttall was the first author to point out the affinity of *Monotropa* to *Pyrola*, and by Warming (1912) this classification has been accepted.

Thus the family *Pyrolaceae* includes *Monotropa* and its allied genera, *Pterospora*, etc. Some few points in the family diagnosis as written by Warming (op. cit., p. 350) are not exactly correct. The anthers are not awnless in all these plants; they are 2-awned in *Pterospora*. The flowers are not always destitute of nectaries; such occur in *Chimaphila*, *Moneses*, and *Pyrola secunda*. Finally, *Pyrola aphylla* is neither leafless nor poor in chlorophyll.

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EXPLANATION OF PLATE 156.

Chimaphila umbellata. Fig. 1, flower-bud, showing the stigma perfectly free, × 3. Fig. 2, flower just opened, the anthers kept in a horizontal position, × 3. Fig. 3, a mature flower, showing the anthers in a vertical position, × 3. Figs. 4 and 5, stamens of same flower drawn in fig. 3, × 6. Fig. 6, a stamen, dorsal face, from the bud drawn in fig. 1, × 6. Fig. 7, base of the ovary of a mature flower, showing the disk (white in the figure); stamens, petals, and sepals removed; × 6.

Chimaphila maculata. Fig. 8, a mature flower; anthers held in a horizontal position; × 3. Figs. 9, 10, and 11, three stamens of same flower, ventral, dorsal, and side view, × 6. Fig. 12, a flower-bud, showing the pistil with the disk (D) at the base and one stamen; the other parts removed; × 6. Fig. 13, longitudinal section of same pistil; D = the disk; × 6. Fig. 14, part of anther, showing the 2-lobed pore.

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CLINTON, MARYLAND.

FURTHER LIGHT ON OUR PURPLE-FLOWERED EUPATORIUMS.

KENNETH K. MACKENZIE.

LAST year Dr. S. F. Blake on his visit to England at my request kindly examined and made photographs of and notes on some of the specimens of North American purple-flowered Eupatoriums preserved in some of the old herbaria there. American botanists are certainly under obligation to Dr. Blake for the care he gave to this matter. This information and other information which has come to hand have thrown much additional light on the problem of the proper identification of these plants heretofore discussed by Prof. K. M. Wiegand and myself in RHODORA (**22**: 57 and **22**: 157). The facts to be added to the discussion may be grouped under the different species as follows:

EUPATORIUM TRIFOLIATUM

Dr. Blake's notes are as follows: "Clayton 620, Brit. Mus.—Leaves lanceolate, cuneate into petiole, thin, penninerved, beneath gland-dotted and along veins sordid-pilosulous; stems essentially glabrous